Final Equations

$$v(t) = \frac{dx(t)}{dt} \approx \frac{\Delta x}{\Delta t}$$

$$a(t) = \frac{dv(t)}{dt} = \frac{d^2x(t)}{dt^2} \approx \frac{\Delta v}{\Delta t}$$

for constant a:

$x(t) = \frac{1}{2}at^2 + v_o t + x_o$ and

$v(t) = at + v_o$

$$F = ma$$

Force laws:

$$F = -mg$$

$$F_{friction} = -\mu F_{normal}$$

$$F = -kx$$

$$F = -\alpha v$$

$p_{before} = p_{after}$,

$$\sum_i m_i v_{i\ before} = \sum_i m_i v_{i\ after}\ .$$

$$K_{before} + U_{before} = K_{after} + U_{after}$$

$$K = \frac{1}{2}mv^2$$

$$U = -\int F dx$$

$$U = mgy$$

$$U = \frac{1}{2}kx^2$$

$$|v| = \sqrt{\left(v_x^2 + v_y^2 + v_z^2\right)}$$

$$v_x = v\cos(\theta)$$

$$v_y = v\sin(\theta)$$

$$F_x = ma_x$$

$$F_y = ma_y$$

$$p_{xbefore} = p_{xafter}$$

$$p_{ybefore} = p_{yafter}$$

$$E_{total} = U + \tfrac{1}{2}m\left(v_x^2 + v_y^2 + v_z^2\right)$$

$$(x,y) = R(cos\omega t, sin\omega t).$$

$|F_{centripetal}| = mR\omega^2. = mv^2/R$ (and the equivalent acceleration formulae)

linear	**rotational**
position, x	angle, θ
velocity, v	angular velocity, ω
acceleration, a	angular acceleration, α
force, F	torque, $\tau = r_{perp}F$
momentum, p=mv	angular momentum, $L = I\omega = r_{perp}p$
mass, m	rotational inertia, $I = \sum_i m_i r_i^2$

$$x(t) = A\cos(\omega t + \phi)$$

$$\omega^2 = k/m$$
$$\omega^2 = g/l$$

$$T = 2\pi/\omega$$

$$f(x,t) = A\sin(kx - \omega t)$$

$$k = 2\pi/\lambda$$

$$v_{wave} \text{ or } c = \omega/k = \lambda/T$$

$$\ell = n\frac{\lambda}{2}$$

$$f(x,y,z,t) = A\sin(k_x x + k_y y + k_z z - \omega t) = A\sin(\vec{k}\cdot\vec{r} - \omega t)$$

$$\mathbf{k} = (k_x, k_y, k_z)$$

$$d\sin\theta = n\lambda$$

$$E = hf$$

$$\lambda = \frac{h}{p}$$

$$\Delta p \Delta x \geq \frac{h}{4\pi}$$
$$E = p^2/2m$$

$$E = \frac{n^2h^2}{8mL^2} \quad \text{or} \quad E = \frac{h^2}{8m}\left(\frac{n_x^2}{L_x^2} + \frac{n_y^2}{L_y^2} + \frac{n_z^2}{L_z^2}\right)$$

$$L = \frac{nh}{2\pi} = n\hbar$$

$$n = n_r + n_\theta + |n_\phi| + 1$$

$$\ell = n_\theta + |n_\phi|$$

$$m_\ell = n_\phi$$

$$E = -\frac{2.2 \times 10^{-18}\, J}{n^2}$$

$$L^2 = \frac{\ell(\ell+1)h^2}{(2\pi)^2} = \ell(\ell+1)\hbar^2$$

$$L_z = \frac{m_\ell h}{2\pi} = m_\ell \hbar$$

$$\#\, microstates = \frac{N!}{(N-n)!\,n!}$$

$$S = k_B \ln(\#\, microstates),\ where$$

$$k_B = 1.38 \times 10^{-23}\, J/K$$

$$\frac{dS}{dE} \equiv \frac{1}{T}$$

$$\frac{\text{Prob(A)}}{\text{Prob(B)}} = e^{(S_A - S_B)/k_B}$$

$$\text{Prob}(\varepsilon) = \frac{e^{-\varepsilon/k_BT}}{Z} \quad \text{where} \quad Z = \sum_{\text{all states}} e^{-\varepsilon/k_BT}$$

$$E_{average} = \frac{\sum \varepsilon \cdot e^{-\varepsilon/k_BT}}{Z}$$

$$E_{total} = \frac{3Nk_BT}{2}$$

$$PV = Nk_BT$$

$c = 3 \times 10^8$ m/s

$m_{electron} = 9.1 \times 10^{-31}$ kg

$h = 6.6 \times 10^{-34}$ Js

Quadractic Formula: for $ax^2 + bx + c = 0,\ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$